KNOWLEDGE

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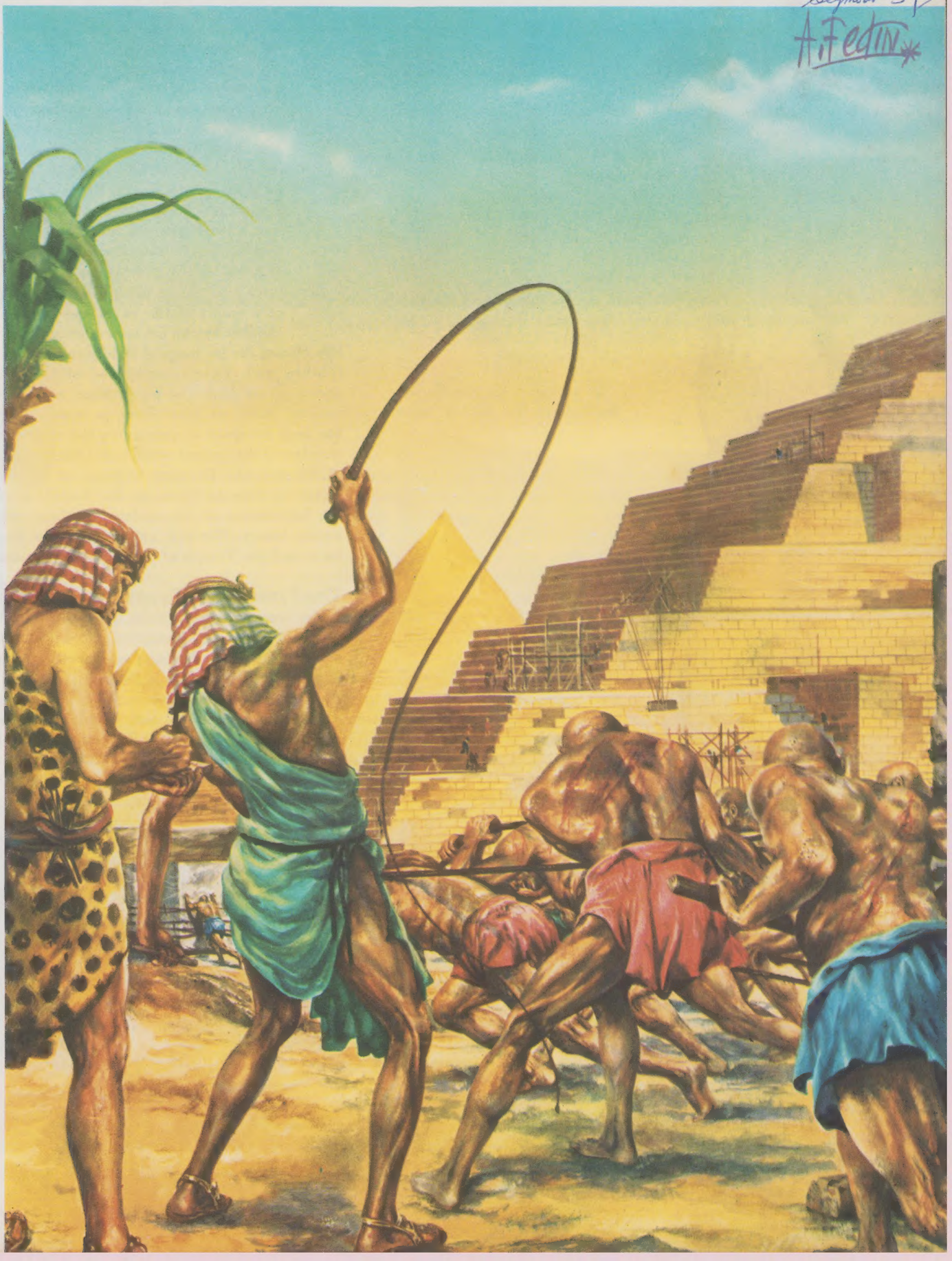

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WONDERS OF THE WORLD

THE Greeks were enthusiastic travellers, and from the earliest times Greek merchants and adventurers brought back 'travellers' tales' about the strange peoples, customs, and buildings to be seen in distant lands. Much of Homer's *Odyssey* is made up of such tales. In the 5th century B C Herodotus, the first Greek historian, applied critical standards to the stories of his predecessors. For example, he was not content to accept the first tale that he was told about the origin of some building. Instead, he collected various stories and explanations in an attempt to arrive at the truth. Herodotus travelled widely and described more accurately than anyone before his time what he had seen. His report on the Great Pyramid of Cheops, for instance, is detailed and, in general, accurate, although some of the measurements he gives are incorrect. Later historians and geographers like Pausanias, Strabo, and the Roman, Pliny, developed the Greek tradition of the 'travel book'. This tradition was particularly strong during the Hellenistic period (4th to 2nd centuries B C) when sight-seeing was fashionable. It must have been in the guide-books of this period that the first lists of wonders of the world appeared. The writer who compiled the first known list of seven wonders – that number was doubtless chosen for its magical significance – was Antipater of Sidon (2nd century B C). Later another list of seven 'authentic' wonders was drawn up by Philon of Byzantium; and even though there are other ancient works as marvellous as some of Philon's wonders, his list has been accepted as preserving the original tradition. Philon's seven wonders of the ancient world were: the Pyramids of Egypt; the Colossus of Rhodes; the Hanging Gardens of Babylon; the Mausoleum; the statue of Zeus at Olympia; the Temple of Artemis at Ephesus; and the Lighthouse at Alexandria. Of these only the Pyramids survive almost intact. The rest, except for a few fragments from the Mausoleum and the Temple of Artemis, have vanished.

The Colossus of Rhodes, as depicted in the Middle Ages

The Pyramids of Egypt

These were gigantic tombs built so that the dead bodies of the pharaohs might lie mummified and undisturbed. The most impressive are the three which stand on the Giza plain near Cairo – those of Cheops, Chephren, and Mycerinus. Of these the largest is the Great Pyramid of Cheops, built c. 2720 B C. It covered an area of about 13 acres, measured 481 feet in height, and was 756 feet along each side of the base. It was built of about 2,300,000 blocks of limestone, each weighing some 2½ tons. The erection of this pyramid, which

The Pyramids of Egypt – massive tombs of the pharaohs

Previous page: Egyptian overseers lash the sweating slaves who struggle to haul great blocks of stone weighing more than two tons into position to build the Great Pyramid

King Hattusilis I on his deathbed summons the Hittite nobles in order to name his successor

THE HITTITES

IN 1812 a traveller in Syria noticed in the town of Hama a stone which was covered with small signs and figures in an unknown script. The writing was *hieroglyphic* (writing in the form of pictures). In the same town 50 years later more stones were found inscribed with similar signs, and yet another was observed in the wall of a mosque at Aleppo. Fragments of this hieroglyphic script were also found on a great rock carving at Ivriz, in the Taurus Mountains of Anatolia (now Turkey), and elsewhere in Asia Minor. The script was a mystery. But in 1876 an Englishman, A. H. Sayce, proposed a solution: that the inscribed stones, the carvings at Ivriz, and other unidentified carvings and relics in Anatolia, should all be ascribed to the Hittites, who at some time in the distant past must have inhabited most of Asia Minor.

This was a remarkable theory, for previously all that was known about the Hittites was contained in a few Old Testament references to them. They were one of the tribes living in Palestine when the Israelites entered the Promised Land, and there are only one or two references to 'the kings of the Hittites' which suggest that they were of any importance. No one had guessed that there was once a flourishing Hittite empire outside Palestine.

Soon, however, new archaeological discoveries began to confirm Sayce's theory. A collection of the diplomatic letters of the Egyptian kings was found inscribed on clay tablets at El Amarna. These letters covered the years 1370–1348 B C, and several times mentioned the Hittites as the inhabitants of a powerful, independent kingdom. One letter was actually written by the Hittite King Suppiluliumas, on the occasion of King Ikhnaton's accession to the throne of Egypt. With the excavation of Boghazköy in 1906 the full extent and power of the Hittite empire was revealed. German archaeologists dug up about 10,000 inscribed tablets. The writing on most of these was in the Hittite language (in the wedge-shaped *cuneiform* script illustrated right). But the Hittite language was not yet understood. However, the presence of words and phrases in Akkadian, the language of Babylonia which was understood, enabled scholars to begin to decipher the tablets and build up a picture of a great civilisation centred around Boghazköy, which was called Hattusas by the Hittites. Scholars could also begin to piece together the story of this people who had been utterly forgotten since the Assyrian conquest of Syria in the 8th century B C destroyed the last remnants of Hittite civilisation. We now know that their language was of the Indo-European group, suggesting that they were a branch of the Indo-European family.

The divine guardian of the King's Gate at Hattusas; from a carved relief

Clay tablet inscribed in the cuneiform *script of the Hittites*

The Hittite empire with its principal cities

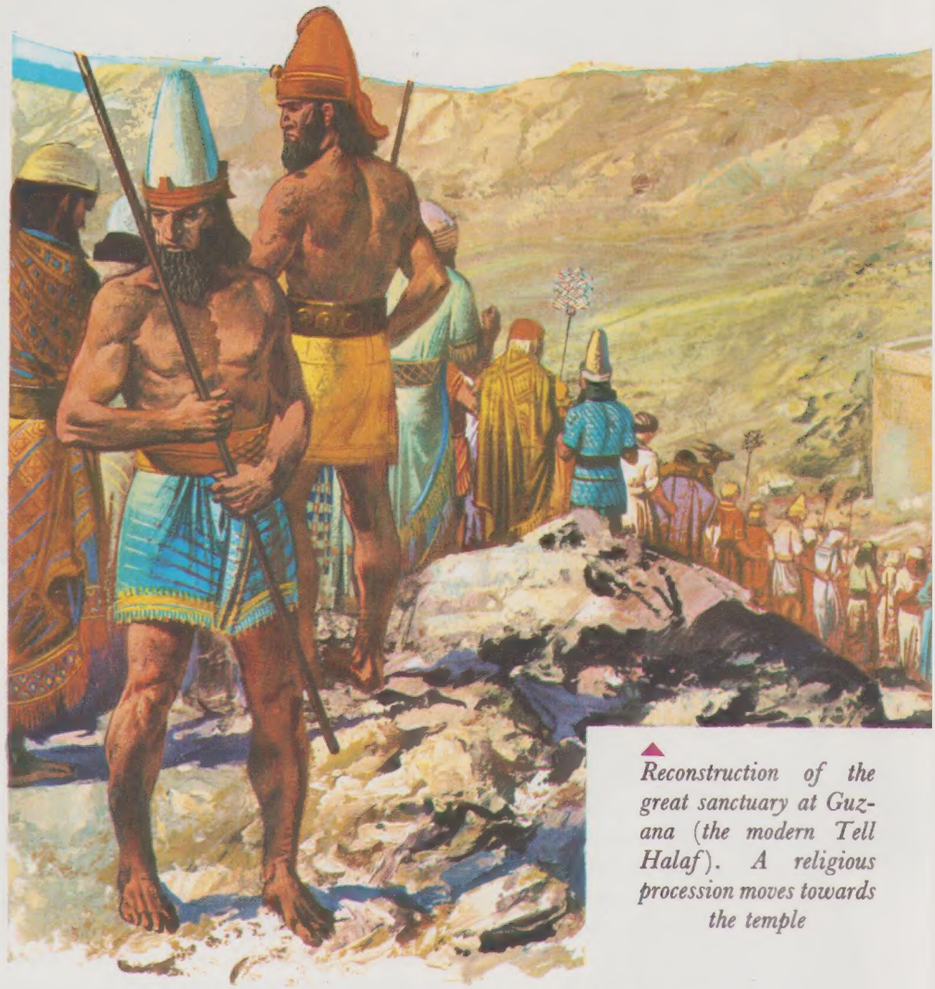
The Old Kingdom

Hittite history begins shortly after 2000 B C. The land of the Hittites is the high Anatolian plateau, bounded to the north by the Black Sea, and to the south by the Taurus mountains. Hattusas, situated within a great loop of the Halys river, was a natural site for the capital – easily fortified, and placed at the junction of two important trade routes. King Labarnas, however, from whom the Hittite kings traced their descent, ruled from some other town – probably Kussara. According to tradition it was he who united the kingdom and extended the frontier as far as the Aegean Sea in the west. His successor, Hattusilis I, wisely adopted Hattusas as his capital. Under Hattusilis and Mursilis I the Hittites began to expand southwards and eastwards to the rich plains of Syria south of the Taurus Mountains. But internally the kingdom was weakened by continual palace intrigues over the succession to the throne, and these domestic quarrels led to the loss of what Hattusilis and Mursilis had gained. Telepinus (c. 1525 B C), the last ruler of the Old Kingdom, succeeded in restoring unity, and solved the problem of the succession by making the Crown hereditary. From then on the authority of a new king was secure from rival claimants.

The empire

From the 15th to the 13th century, the period of the empire, three great powers dominated the area east of the Mediterranean: the Egyptians, the Hittites, and the Hurrians, who inhabited the kingdom of Mitanni. The high point of Hittite power was the reign of King Suppiluliumas (c. 1380–1340 B C) who defeated Mitanni, subdued the whole of Syria, and installed his own sons on the thrones of Aleppo and Carchemish. His power was such that the widowed queen of Egypt sent to Suppiluliumas asking to be given one of his sons in marriage rather than take a new husband from among her own people. The scheme failed, for the son was murdered on his arrival in Egypt; but it shows the international respect which the Hittites then commanded.

Until the decline of the empire the Hittites had to campaign regularly on the northern frontier and in western Asia Minor; but they kept Syria, despite the attempt of Rameses II to win it for Egypt. Rameses was beaten by King Muwatallis at Kadesh in 1286. This was the last important Hittite victory; 50 years later the empire was destroyed by a great shift of populations throughout the Near East. Many of the Hittites fled to Syria, and a new people, the Phrygians, took their place in Anatolia.



Reconstruction of the great sanctuary at Guzana (the modern Tell Halaf). A religious procession moves towards the temple

The king

In Hittite society the king was supreme. He was chief priest, judge, diplomat, and commander of the army. The people regarded him as divinely favoured, and worshipped their dead kings as gods.

The Neo-Hittites

In the Syrian provinces to the south of the old empire traces of Hittite culture lasted for a further 500 years. The 'kings of the Hittites' referred to in the Old Testament are the rulers of small Syrian kingdoms of this time.

Neo-Hittite chariots of war; note the six-spoke wheels

Characteristic Hittite faces (from sculptures)

Religion and art

The Hittites were a religious people. The king was expected to perform his religious duties without fail, and Mursilis II actually interrupted an important campaign abroad in order to get home in time for the springtime festival of the earth. The Hittites regarded their gods as immortal, but endowed them with human needs such as food and sleep. They sacrificed to their gods, and practised the art of divination to discover what fate lay in store for them and what was the divine will. Chief among their many divinities were the weather god and his consort, the goddess of the sun.

Inscribed rolls of lead; behind them, an example of the hieroglyphic *script*

The best art of the Hittites is religious. They excelled at carving in relief on the gates of palaces and even on rock faces as at the impressive Yazilikaya ('inscribed rock') near Hattusas. Hittite seals, as you can see below, were produced in many different shapes.

The Hittites were, by the standards of the time, a humane people. Their legal code, for example, recognised that compensation is more important than revenge. And, on the whole, they were merciful to the peoples they conquered. Yet we have little to remember this remarkable people by except the few examples of their art which remain.

Hittite seals of different shapes

Pottery used in Asia Minor in about the 19th century B C, possibly made by the early Hittites

WAY OF LIFE

The Hittites depended largely on agriculture. Most of them spent their time raising livestock or growing crops on the rocky Anatolian plateau. Their main products were barley for bread and beer, olives for oil, and fruits, especially grapes, and their livestock consisted chiefly of sheep and goats.

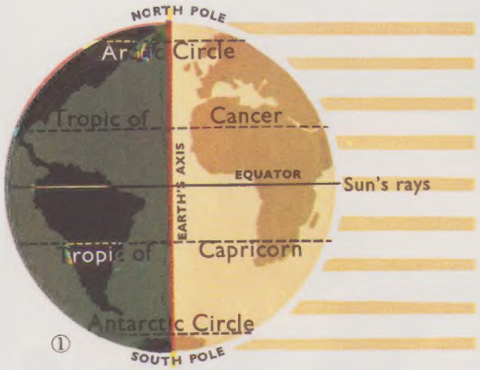
THE SEASONS

ON 18th April 1964 the Australian cricket team arrived in England after a voyage of some three weeks across the Indian Ocean, the Red Sea, the Mediterranean, and the Bay of Biscay. When they started they had just finished the summer cricket season at home in Australia, but when they arrived at Southampton they were looking forward to another season's cricket in England. For while Australia is in the southern hemisphere England is in the northern hemisphere, and although April is early autumn in the southern hemisphere, in the northern countries it is spring.

What causes this complete reversal in the seasons in the two hemispheres? Why does Christmas Day fall in the middle of winter in the north, while people in Sydney, Cape Town, and Buenos Aires eat Christmas dinner on the beaches? The answer is found in the rotation of the Earth and its inclination with respect to its plane of orbit round the Sun.

The rotation of the Earth

The Earth is ceaselessly spinning on its axis, always presenting a changing face to the Sun, and this causes day and night (see page 2902). But while this is happening the Earth is also moving along its elliptical orbit around the Sun; and this orbit takes 365¼ days to complete (see page 1996). While this is happening the axis on which the Earth is spinning remains inclined in the same direction – that is, not perpendicular to the plane of orbit but tilted at 23½°. This means that for half of the Earth's orbit it is the northern hemisphere which is more inclined towards the Sun and for the other half it is the southern hemisphere. And it is warmer in the hemisphere inclined towards the Sun.



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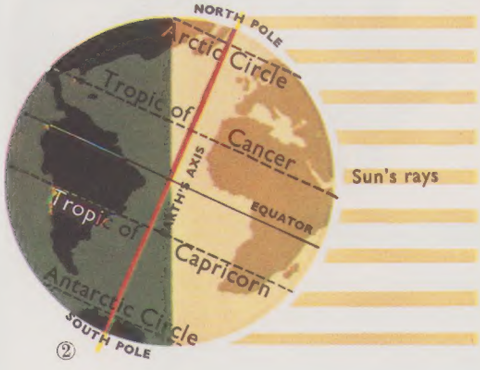


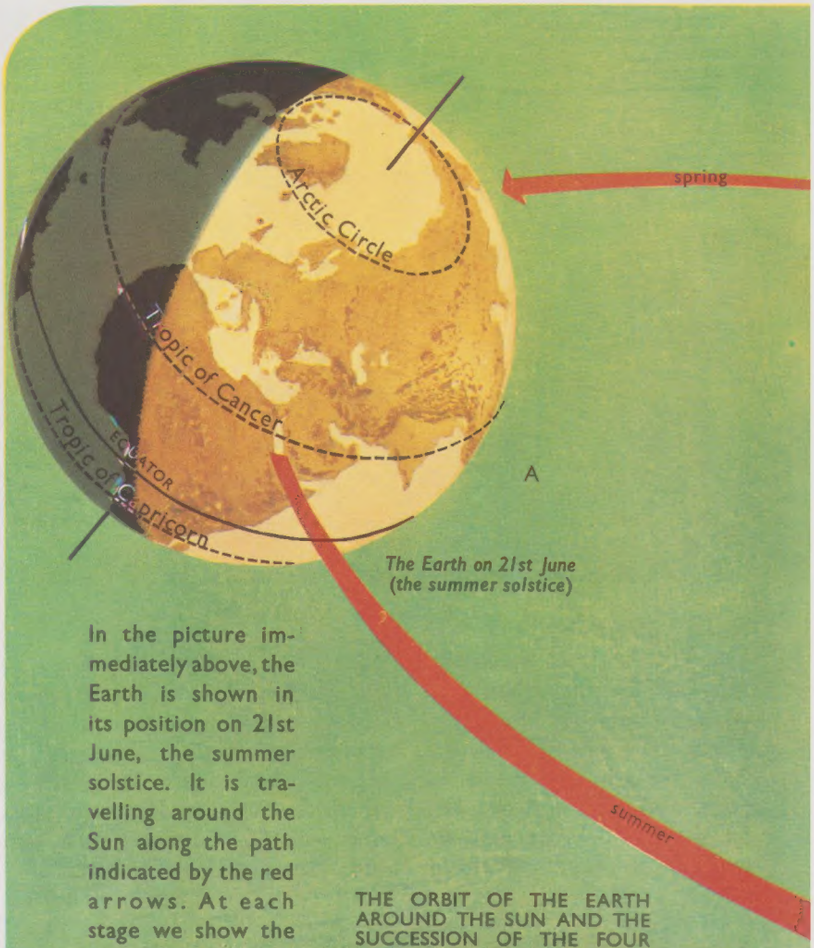
②

The Earth takes one year to complete each journey along its orbit around the Sun; if, while it did this, its axis remained not inclined but at right angles to its plane of orbit then it would always be exposed to the rays of the Sun in the same way ①. The Sun would always be overhead at the Equator at midday, and the day would always be exactly 12 hours long, except at the poles, where the Sun would always be just on the horizon. And, all year round, the distribution of light and heat in the different parts of the world would stay the same.

Since the Earth's axis is inclined and it slopes in the same way throughout its journey, during most of its orbit one hemisphere will have a longer time in the sun – that is, a longer day – than the other. If you look at figure ② you can see that this is so. The northern hemisphere is tilted towards the Sun; the part of the Tropic of Cancer which is in sunlight is much longer than the part which is in darkness, while the reverse is true of the Tropic of Capricorn.

WHY SOME PLACES ARE HOTTER THAN OTHERS

Since the Earth and the Sun are so far apart, the Sun's rays are nearly parallel when they reach the Earth. Where these rays arrive perpendicular to the Earth's surface they only strike a small area, but where they are oblique to the Earth's surface they are spread out over a wider area. Clearly the smaller the



In the picture immediately above, the Earth is shown in its position on 21st June, the summer solstice. It is travelling around the Sun along the path indicated by the red arrows. At each stage we show the northern hemisphere in more detail than the southern.

THE ORBIT OF THE EARTH AROUND THE SUN AND THE SUCCESSION OF THE FOUR SEASONS

SUMMER

The Earth at A is shown on 21st June, the summer solstice and the longest day of the year in the northern hemisphere. At midday the Sun is overhead at the Tropic of Cancer – the farthest latitude north at which it is ever directly overhead.

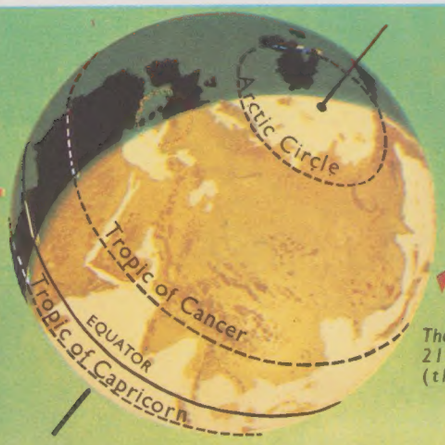
The area within the Arctic Circle, including the North Pole, has 24 hours of daylight although the Sun is always low on the horizon; for this reason it is sometimes called 'the land of the midnight sun'. In the southern hemisphere the Sun's rays are arriving more obliquely, and within the Antarctic Circle the Sun is never seen.

AUTUMN

The Earth has moved along its orbit to B, and it is now 23rd September. The circle of illumination (see page 2902) between light and darkness passes through both poles. In temperate latitudes in the north, such as Britain, it is autumn. The midday Sun is overhead at the Equator, and its rays strike the northern hemisphere more obliquely than they did in June. From now until March the North Pole will remain in darkness, while the South Pole will have unceasing light.

area struck by the same number of rays, the more intensely it will be heated. The rays of the Sun only strike perpendicularly in the region lying between the Tropics of Cancer and Capricorn, so naturally this is the hottest region of the Earth. Although the Earth's orbit round the Sun is elliptical, and therefore the distance between the two

varies, the Earth is so many million miles from the Sun that this variation makes little difference to the amount of heat received.



D

The Earth on 21st March (the spring equinox)

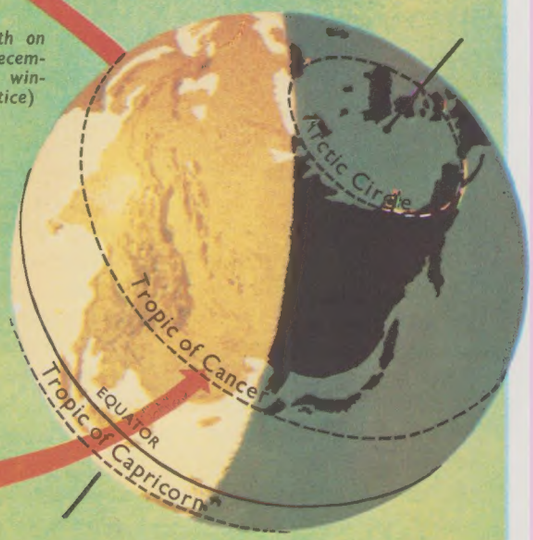
SPRING

On 21st March the Earth reaches D. It is in a similar position with respect to the Sun as it was at B; but now it is the northern hemisphere, not the southern, which is tilting towards it. The North Pole emerges into sunlight again, while the South Pole slips into darkness. The increasing warmth and lengthening hours of daylight stimulate the growth of plants in the northern temperate lands; and the days get steadily longer and warmer as the Sun's rays strike the northern lands less obliquely, bringing summer once more.

winter

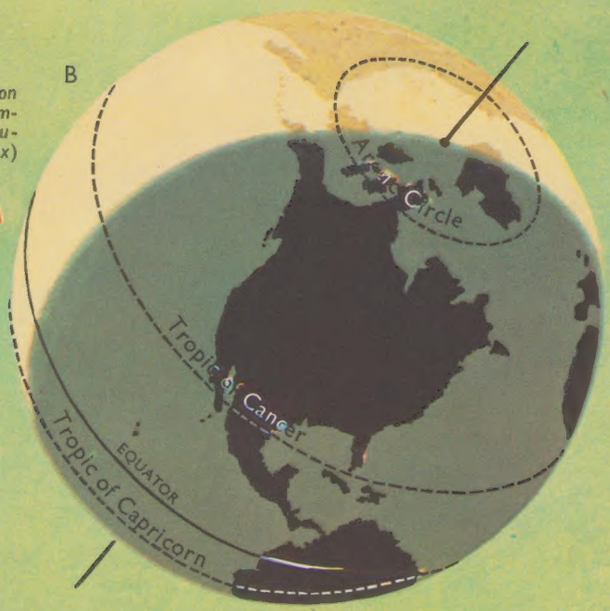
The Earth on 22nd December (the winter solstice)

C



The Earth on 23rd September (the autumn equinox)

B



autumn

WINTER

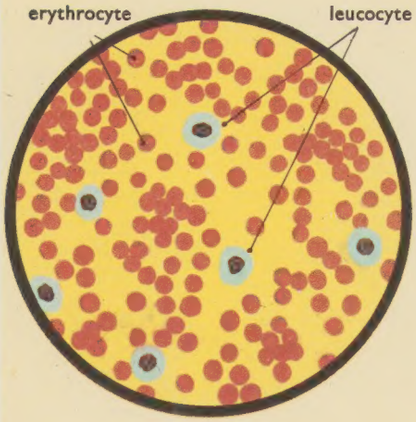
22nd December (C) is the shortest day in the year for those who live in the northern hemisphere, but in South America, South Africa, and Australia it is high summer. The Sun is now overhead at midday at the Tropic of Capricorn – its farthest south – and its rays strike the northern hemisphere more obliquely. In Antarctica it is constant day, while the Sun has disappeared from the Arctic Circle.

The effect of the four seasons is clearly shown in the countryside in temperate climates; above is the same scene in spring ①, summer ②, autumn ③, and winter ④

Christmas Day in Milan, Italy, and Buenos Aires, South America

ANAEMIA

ANAEMIA is not a single disease like measles or chicken-pox but rather a large group of diseases, all of which have one factor in common – a subnormal amount of *haemoglobin* in the blood. In all of the many types of anaemia this low level of haemoglobin is accompanied by other characteristic abnormalities, particularly in the red blood cells or *erythrocytes*. Consequently, an experienced *haematologist*, merely by examining the blood of an anaemic patient, can diagnose the particular type of anaemia from which that patient is suffering.



The appearance of normal blood under the microscope (× 400)

Today anaemia is one of the most common causes of chronic ill health all over the world. In developed countries it occurs mainly in women, whose requirements of iron for haemoglobin synthesis are greater than those of men, while in underdeveloped countries anaemia often results from infestation with parasitic worms, particularly hookworms.

THE CAUSES OF ANAEMIA

Although there are many different kinds of anaemia they can all be classified in one or other of three groups, depending on the way in which they are caused.

1. **Haemorrhagic anaemia.** These are the easiest kinds of anaemia to diagnose, for it is obvious that if blood is lost through haemorrhage there will be a reduction in the amount of haemoglobin and the number of erythrocytes. Fortunately, as long as the patient's diet is good, new cells can quickly form in the bone marrow to replace those which were lost. Recurrent haemorrhages, however, may cause so much loss of blood that the bone marrow runs out of iron and is therefore unable to make sufficient new cells, so anaemia occurs.

2. **Dyshaemopoetic anaemias.** These anaemias occur when the bone marrow is unable to make new erythrocytes to replace the old ones removed from the blood by the spleen. The process of erythrocyte formation, *haemopoesis*, is an exceedingly complicated one which depends on an adequate supply of iron and several vitamins in the diet. Should these substances not be available in sufficient quantities both haemoglobin and red cell formation are disrupted, and one of the *dyshaemopoetic anaemias* results.

3. **Haemolytic anaemias.** These anaemias are due to the destruction, or *haemolysis*, of a proportion of the erythrocytes as they circulate in the body. Haemolysis is common in patients suffering from malaria, a disease in which the blood cells are invaded and destroyed by a parasite (see page 1891).

THE SYMPTOMS OF ANAEMIA

The subnormal amount of haemoglobin circulating in the blood and the consequent reduction in the blood's oxygen-carrying capacity produce the characteristic symptoms of anaemia. Anaemic patients have pale skins and lips, and they usually tire easily and have poor appetites. If the anaemia is severe they may also suffer from palpitations, for the heart has to beat inordinately hard to pump sufficient quantities of the watery blood to the tissues.

A sample of blood is obtained from the patient's fingertip

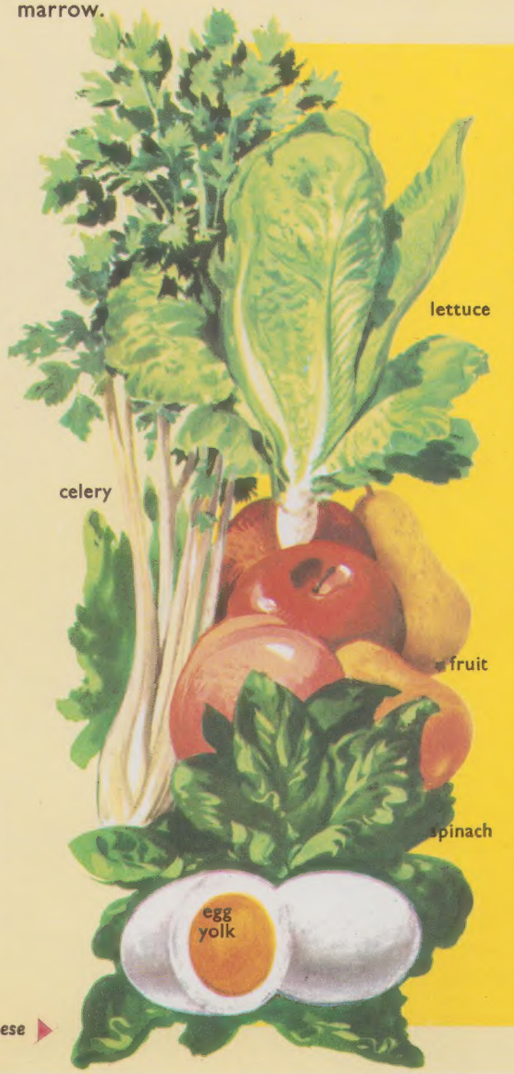
THE DIAGNOSIS

Many forms of anaemia can be diagnosed by a doctor as he listens to his patient relating the history of his illness. Nevertheless most doctors also take a sample of the patient's blood, so that the diagnosis which has been reached in the surgery may be confirmed by the haematologist in his laboratory.

Blood samples are usually taken either from the tip of the patient's finger or from the lobe of his ear. In most cases the amount needed is so small that it can be obtained almost painlessly by means of a prick with a needle held in a special holder.

When the blood sample reaches the laboratory the amount of haemoglobin that it contains and the number of red cells present in one cubic millimetre are measured. Additionally a thin film of the blood is smeared on a glass slide and (after being stained so that the cells can be seen more easily) examined under a microscope.

Just occasionally the clinical examination of the patient and the tests on the blood sample fail to give an exact indication of the nature of the anaemia. In such circumstances the haematologist can obtain further help by examining a fragment of the patient's bone marrow.



The body's requirements of iron for haemoglobin synthesis are provided by foods such as these

TREATMENT

The most common form of anaemia in Britain is a mild dyshaemopoetic anaemia which results from inadequate dietary intake of iron. The disease can be cured by the administration of ferrous sulphate tablets, and a recurrence prevented if the patient follows a diet which contains adequate amounts of green foodstuffs.

The anaemia known as *pernicious anaemia* is the result of a deficiency of vitamin B_{12} in the bone marrow. It can be treated by injections of this vitamin at regular intervals.

DANES IN BRITAIN

ON page 894 we saw how King Alfred defeated the Danes, who at one stage in the 9th century looked like overrunning England. But the Danes were not so decisively defeated that they returned to their native country. The Danish conquest of large areas of England was a fact which not even Alfred's brilliant defence of Wessex could alter. Alfred's main military achievement was to prevent England from becoming a Danish kingdom.

In 874 the 'Great Army', which had been harrying England so mercilessly since 865, began to break up. One division marched north and settled in Yorkshire between the Humber and the Tees. In 877 another division occupied eastern Mercia. In 879 Guthrum and his army arrived in East Anglia – a year after his defeat by Alfred at Ethandune.

THE BEGINNING OF DANELAW

Between 880 and 890 the boundaries of Alfred's and Guthrum's kingdoms were agreed by the two rulers. They were based on the Roman road, Watling Street, and the river Lea (see map 2 on next page). This division of territory between Dane and Saxon was the beginning of what became known as the Danelaw – the area between Watling Street and the river Lea, in the south, and the river Tees, in the north, in which the laws and customs of the Danes were used as opposed to those of the Saxons.

To begin with there had been no question of the Danes acknowledging Saxon overlordship. But within 50 years Alfred and his successors had definitely established their rule over the Danes (see page 1882). Yet this did not mean that the Saxon kings imposed their laws or administrative system on the Danes. That would have been quite impossible with a people accustomed to doing things their own, and often unique, way. The Saxon government had to accept that in the areas in which the Danes settled or controlled they should preserve their laws and customs. Indeed, much of our knowledge of these laws and customs is obtained from the various confirmations that the Saxon kings made of them. The attitude of the Saxon kings towards the Danes is summed up by Edgar (959–975) who acknowledged in 962 that the 'Danes were a law unto themselves'. In fact, when he was imposing penalties for cattle stealing in north and south England he left the Danes to decide for themselves the nature of the punishment 'according to such good laws as they may best choose'.

THE EXTENT OF THE DANELAW

Although the laws and customs of the Danes prevailed throughout the Danelaw, it does not follow that the Danes settled heavily through all of it (see map 1 on next page). It is very difficult to gauge how many Danes did come to settle in the Danelaw, though not so difficult to know where they settled. For instance, place-name endings can give us clues – names ending in 'by', 'thorp', or 'thwait' are Danish in origin. From the distribution of Danish place-names we can tell that there were quite heavy settlements in the eastern half of the Danelaw but not in the west. Settlement was particularly heavy in the area of the Five Boroughs – Nottingham, Stamford, Lincoln, Leicester, and Derby. These originated as five fortified camps which were the defensive bases of the section of the 'Great Army' which had settled in eastern Mercia. Added evidence of heavy Danish settlement around the Five Boroughs and in certain other areas is the extraordinary number of free peasants found there in the Domesday Book of 1086 (see page 1120) – it is fairly certain that these peasants were the descendants of the soldiery of the 'Great Army'.

HOW THE DANELAW DIFFERED

How did the Danelaw differ from the rest of England? First there were the obvious legal differences. Sometimes the differences between the Danelaw and the rest of England are only in name. For instance, the basic Anglo-Saxon grouping of villages for the administration of justice, the *hundred,* has an equivalent in the Danelaw – this was known by the Danes as the *wapentake* (the name comes from the symbolical flourishing of weapons to denote agreement of an assembly). But there were many more profound differences in the two legal systems. For instance, in the Danelaw compensation paid to a lord for the loss of one of his men varied in accordance with

A disturbing sight for the Anglo-Saxons – the ships which brought the Danes to England, first as plunderers, then as settlers

MAP 1 MAP 2

the dead man's rank, whereas in the Anglo-Saxon area it varied in accordance with the rank of the dead man's lord.

A remarkable feature of the Danelaw is the high scale of fines exacted for serious crimes of violence. For the gravest of these crimes Danelaw prescribed fines which were out of all proportion to those imposed elsewhere. In some cases they were so heavy that they must have fallen on districts rather than individuals.

One of the more remarkable aspects of the Danish legal system was the Jury of Presentment, whereby 12 leading thanes in each wapentake undertook to *present* any guilty man for trial by ordeal.

In social organisation there was one really striking difference between Danelaw and the rest of England. This was the number of *sokemen*, or free peasants, found in the Danelaw. These held a higher position in society than the other peasants, and although they did have some obligations to a lord, these were neither burdensome nor humiliating. This is in marked contrast to the relatively few freemen on Anglo-Saxon lands.

The Danes had different divisions for their land to those used in the Anglo-Saxon areas. The Anglo-Saxons measured their fields in hides of roughly 100 acres. The Danes divided the soil into *ploughlands* of some 120 acres – an area which could normally be kept cultivated by a team of eight oxen. The normal unit of a Danish peasant-holding was an *oxgang* – an area of about 15 acres. This meant that the peasant probably contributed an ox to an eight-ox team.

THE EFFECTS OF DANELAW

The effects of the Danelaw lasted until the end of the 11th century. Indeed, the Norman administrators of William the Conqueror referred to the separate laws of the West Saxons and Mercians and the Danes. It was not until the 12th century, when the English monarchy began drastically to reorganise the legal system, that the Danish peculiarities either disappeared or were merged into the laws of England.

THE DANES COME AGAIN

The first Danish settlement is by no means the end of the story of the Danes in England. Towards the end of the 10th century another and just as serious wave of Danish invasions began. And by this time England was much less prepared for it than at the time of Alfred. Ethelred (978–1016), aptly named 'the Unready', was now at the helm of state. Ethelred was particularly incompetent and as well employed the rather stupid policy of buying the Danes off with money (*danegeld*). Naturally the Danes came back for more. In 1003 and 1013 England suffered invasions from the mighty King of Denmark himself – Swein Forkbeard. On his second invasion Swein determined to conquer the country and took with him a remarkable young man – his second son, Cnut.

EDMUND IRONSIDE

By 1014 Swein was in control of England and Ethelred had fled to Normandy. But in the hour of his triumph Swein died. Ethelred returned, and Cnut was forced back to Denmark. But in 1015 he returned to England with a large fleet.

The real leader of the English cause was now Edmund Ironside (1016–1017), Ethelred's eldest surviving son. But in 1016 Ethelred

During his siege of London in 1016 Cnut ordered canals to be dug to bring his ships into a more commanding position

Ethelred the Unready (978–1016)

died, and one half of the English nobility chose Cnut as king, thinking that Edmund could not possibly win.

But Edmund was not going to go down without a fight. Moreover, he had the support of London. The city withstood a vigorous siege by Cnut, who even dug canals to bring his ships into a more commanding position. Eventually Edmund was defeated at the battle of Assandun – the defeat was, to a certain extent, due to the treachery or cowardice of Eadric Streona, Ealdorman of Mercia.

Edmund was now forced to agree to the partition of the country with Cnut. A few months later he died. So Cnut (1017–1035), at the age of just over 20, was King of England. In 1018, at the death of his brother, he became King of Denmark as well.

CNUT THE GREAT

Cnut is one of the more remarkable sovereigns of the Middle Ages. Not only did he show himself an enterprising war-leader, he also proved himself to be an able and effective administrator, controlling a vast empire in northern Europe.

His treatment of the English was firm but tactful. In fact, he did his best not to offend their sympathies. He married an English wife, sent the bulk of his forces back to Denmark, gave numerous benefits to the English Church, and used Englishmen, as well as Danes, in the task of governing the country.

One of his more significant changes was to divide England up into four great earldoms. Although this was to result in decentralisation in the succeeding reigns, Cnut intended it as a measure to bring more effective government. It is also probable that he had a permanent administrative household of clerks. He did not make any innovations in the already complicated English legal system, although he did issue a code containing many of the laws of previous kings.

Cnut took a more active part in foreign affairs than any previous king. He had to defend Denmark's empire along the southern shores of the Baltic from the aggression of Norway and Sweden. Moreover, he was also interested in the affairs of the rest of Europe. In 1026 he travelled to Rome for the coronation of the Holy Roman Emperor, Conrad II, who was the only European sovereign who could rival Cnut in power. He also gained many concessions for Englishmen from rulers whom he met on the way to Rome, and recorded with pride the respectful reception they gave him.

Englishmen quickly accepted Cnut, and under his fair and effective rule England enjoyed a period of considerable prosperity.

Cnut's two successors, Harold (1035–1040) and Harthacnut (1040–1042), were an anticlimax to his magnificent reign. Harold, his illegitimate son, managed to maintain himself in power for five years until his death. Harthacnut, Cnut's only legitimate son and true heir, was meanwhile occupied with the affairs of Denmark which was being threatened by the rise of King Magnus of Norway. Neither of these two kings accomplished much or could compare in ability or personality with their father.

In 1042, after the death of Harthacnut, the Anglo-Saxon royal family was restored.

Cnut (1017–1035)

THE BRITISH ISLES

On the whole, the Danes confined their activities to England. However, with the submission of Norway to Cnut in 1028 the earldom of Orkney (the north of Scotland) became for a time part of the Danish empire. Moreover, it is possible that the King of Scotland also accepted Cnut's overlordship. The Danes also established themselves in parts of Ireland – but the extent of their dominion was limited.

Edmund Ironside (1016–1017)

NEWTS AND SALAMANDERS

'IT came out of the fire, and look at the colour of it. Could anything be more clear? It was born of the flames.' Very likely such a remark was made back in the Stone Age when the first black-and-yellow salamander which had been hiding among the damp logs of a pile of firewood crawled out on to the hearth to escape the heat of the fire. Salamanders are found throughout most of Europe and temperate Asia, and wherever they occur they are associated with fire; it seems likely that incidents of the kind described above are the origin of this curious belief.

From this beginning the salamander came to be surrounded by an aura of superstition. It could pass through flames unscorched, and to touch it was to risk death by poison. The alchemists even employed it in their misguided efforts to make gold. This brightly coloured cousin of the newts has only recently been accepted as a harmless little animal and a pleasant, docile pet.

Order Caudata – the tailed amphibians

In our article on the Amphibia (page 2657) we referred briefly to the Caudata, the Order which includes newts and salamanders. These animals look rather like lizards and, unlike their relatives the frogs and toads, all possess tails (the word *caudata* means 'having a tail'). Their kinship with frogs is immediately revealed by their life-history: newts and salamanders start life as tadpoles, which live in water and breathe by means of gills. Most of them lay eggs in water, but a few bear their young alive.

A very curious feature of some tailed amphibians is that they never grow up. Instead of losing their gills and leaving the water, they continue to grow and reach full size while remaining water-breathing 'tadpoles', and in this condition they become sexually mature and breed. This queer state of affairs is known as *neoteny*; among the neotenic amphibians are the American mudpuppies (*Necturus*), the olm (*Proteus*), and the axolotl (*Siredon*) of Mexico.

The Caudata, unlike most amphibians, are found mainly in the temperate regions of the northern hemisphere; a few occur in tropical America.

Spectacled salamander

Egg of a newt on a water plant

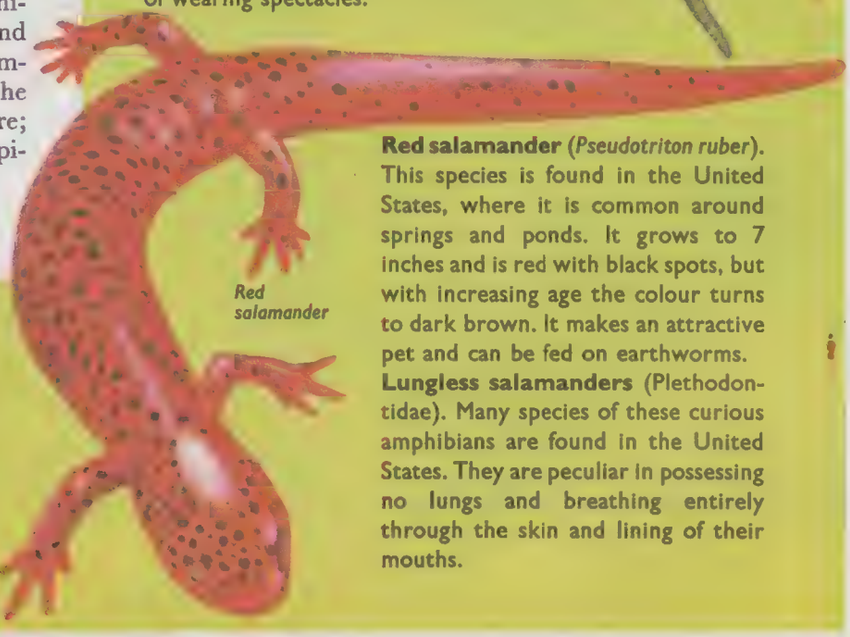
SOME COMMON NEWTS AND SALAMANDERS

Olm

Common salamander

Common salamander (*Salamandra salamandra*). This is the European species about which so many superstitious beliefs were formerly held. They mate in summer, and the females enter the water 10 months later to bear their young alive. When they are born the tadpoles already have their legs, but remain for some time in the water, breathing by means of gills. The skin of a salamander secretes a fluid which causes a burning sensation in the mouth of any animal that bites it, so it is well protected against its enemies. This may be one of the reasons for its being associated with fire.

Spectacled salamander (*Salamandrina terdigitata*). This is a small species, reaching 3 to 4 inches in length, which is found only in Italy. It has a pair of pale marks on its head, surrounding its eyes, which give it the appearance of wearing spectacles.



Red salamander

Red salamander (*Pseudotriton ruber*). This species is found in the United States, where it is common around springs and ponds. It grows to 7 inches and is red with black spots, but with increasing age the colour turns to dark brown. It makes an attractive pet and can be fed on earthworms.

Lungless salamanders (Plethodontidae). Many species of these curious amphibians are found in the United States. They are peculiar in possessing no lungs and breathing entirely through the skin and lining of their mouths.

Alpine newt (*Triturus alpestris*). A common and very pretty species found in the European mountains, especially in the Alps where it occurs up to about 10,000 feet.

Olm (*Proteus anguineus*). This amphibian lives in underground waters in caves in the Balkan region. It spends its life in total darkness and is white, with eyes hidden under its skin. This is a neotenous species, breathing with gills all its life.

Crested or **warty newt** (*Triturus cristatus*). The largest of the three kinds of newts found in Britain, reaching 6 inches in length. In spring, after winter hibernation, they enter ponds to breed, and the males grow a crest along their backs. The tadpoles complete their development in the water during summer and autumn.

Alpine newt

Crested newt

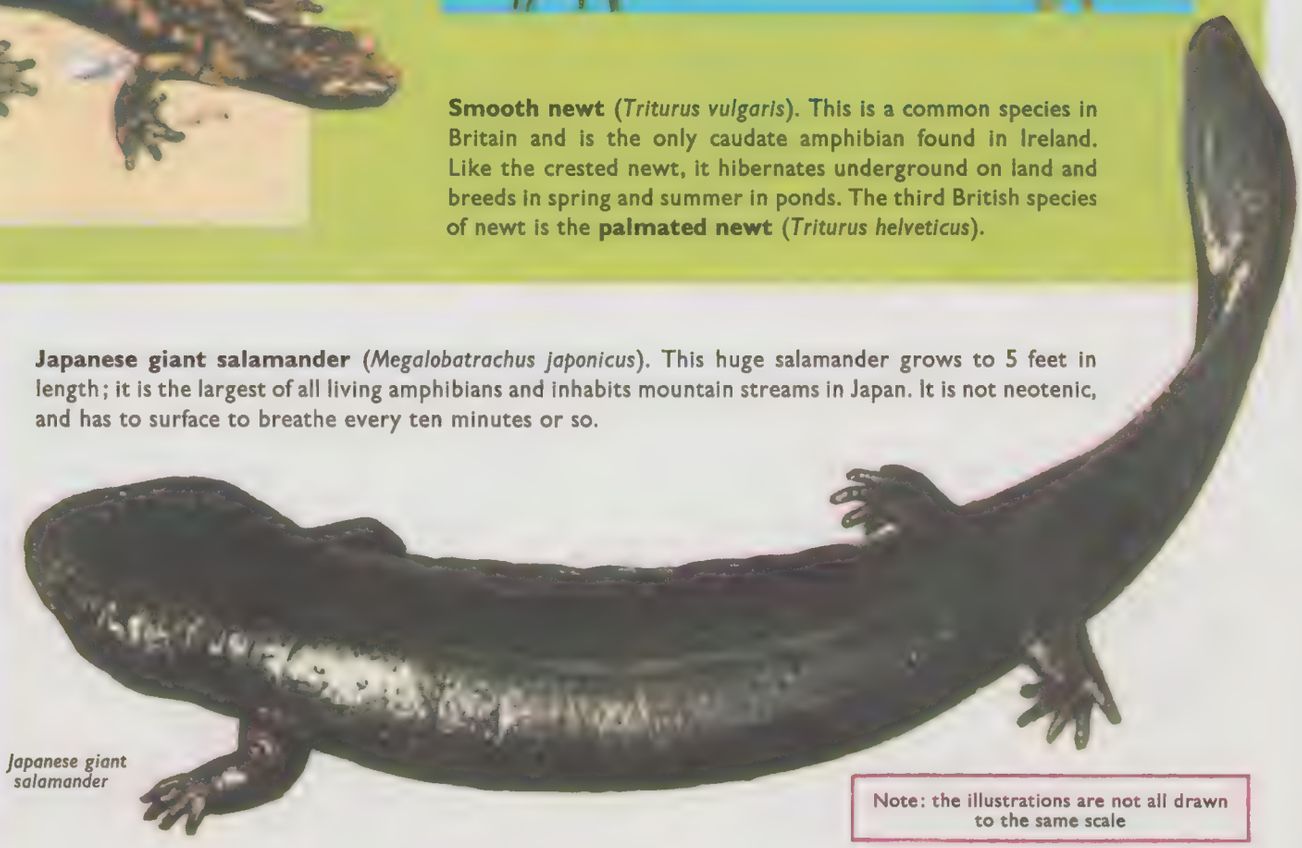
Hydromantes italicus

Smooth newt

Smooth newt (*Triturus vulgaris*). This is a common species in Britain and is the only caudate amphibian found in Ireland. Like the crested newt, it hibernates underground on land and breeds in spring and summer in ponds. The third British species of newt is the **palmated newt** (*Triturus helveticus*).

Hydromantes italicus. This salamander belongs to a genus found both in California and southern Europe; *Hydromantes italicus* is found in southern France and northern Italy. It lives in mountain caves, climbing over the rocks at night to look for the scorpions and beetles on which it feeds. Its tongue can be protruded for over an inch and is probably sticky.

Japanese giant salamander (*Megalobatrachus japonicus*). This huge salamander grows to 5 feet in length; it is the largest of all living amphibians and inhabits mountain streams in Japan. It is not neotenic, and has to surface to breathe every ten minutes or so.



Japanese giant salamander

Note: the illustrations are not all drawn to the same scale

BURMA

Map of Burma

IN March 1942 the Japanese army marched into Rangoon and brought to an end Burma's era of prosperity as a British colony. Although the British began to reoccupy the country in 1944, they did not long impose political control, and in 1948 Burma became an independent republic. However, the ravages of war could not quickly be repaired, for Burma had suffered more than any other south-east Asian country during the Second World War. Added to this was the problem of troublesome racial minorities, many of whom wanted self-government. Today political stability seems to have been restored; but the economy has not yet regained its pre-war level, and exports in particular have been greatly reduced.

THREE GREAT RIVERS

Burma's development has always been closely linked with her great rivers. They provided the main routes for the early settlement of the country; they afforded cheap transport for the products of the interior, notably teak; and they made possible the establishment of one of the world's greatest rice-growing areas. They also offer one of the main means of future expansion, both as a source of hydroelectric power and as a source of irrigation. The most important river in Burma is the Irrawaddy, which is over 1,000 miles long. It rises in the extreme north of the country and flows southwards through very rugged terrain in a series of deep, narrow defiles. Navigation is possible from below Bhamo to the mouth of the river. In its lower reaches the Irrawaddy is about 2 miles wide, but near its mouth it splits up into several smaller channels (distributaries) to form a delta with a mangrove-fringed sea frontage 150 miles long. The Irrawaddy's chief tributary, the Chindwin, is also a vital transport artery.

Burma's other great river is the Salween, which has its source on the high plateau of Tibet (see page 2668). For most of its 1,750-mile-long course it flows in a deep gorge (the longest in the world); frequent waterfalls and the speed of its flow make it unsuitable for navigation except for the last 50 miles of its course.

THE MOUNTAINS

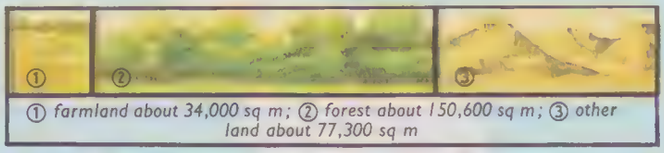
The Irrawaddy and Chindwin, as well as the Sittang river which occupies a former course of the Irrawaddy, flow in a major structural depression running north-south throughout the country. This depression is divided down the middle by the Pegu Yoma, a range which seldom exceeds 2,000 feet; while in the west the Arakan Yoma, a lofty, forest-covered mountain range with a maximum height of over 10,000 feet, separates it from the sea. In the east the depression is overshadowed by the steep scarp edge of the high Shan Plateau which is continued in the lower Tenasserim Hills south of Moulmein.

Typical flooded rice fields and forested hills

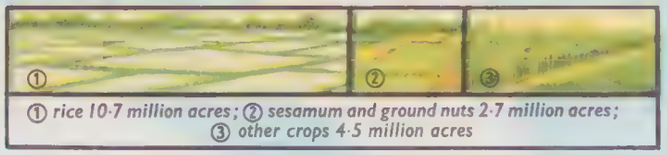
CLIMATE

Burma has a typically south-east Asian climate. Summers are hot and wet, while 'winters', although hot, are relatively dry. The highest temperatures occur between March and May before the summer monsoon breaks, bringing very heavy rainfall and some relief from the oppressive winter heat. The coming of the rains changes the colour of the landscape from a dirty brown to a brilliant green. The exposed coastal areas receive nearly 200 inches of rain a year, but the central depression, which is sheltered from rain-bearing winds by the mountains, receives less than 40 inches; and in the heart of the dry zone, between Mandalay and Pagan, as little as 20 inches may be recorded. Except in the uplands, where temperatures decrease by about 3° every thousand feet of altitude, temperatures are tropical; in Rangoon the temperature ranges from 77°F (monthly mean) in January to 87°F in April, and in Mandalay from 70°F to 90°F in the same two months.

Geographical position and flag of Burma



① *farmland about 34,000 sq m;* ② *forest about 150,600 sq m;* ③ *other land about 77,300 sq m*



① *rice 10·7 million acres;* ② *sesamum and ground nuts 2·7 million acres;* ③ *other crops 4·5 million acres*

A broad street in Rangoon, the capital of Burma

AGRICULTURE

Nearly three-quarters of the people of Burma (see page 2168) are farmers, and most of them live in the delta region of the Irrawaddy, which is known as the 'rice bowl', or in the dry central zone centred on the great bend of the Irrawaddy between Mandalay and Pagan.

Under the British the delta region was developed into one of the world's main centres of rice production, and Burma became the leading supplier of rice to the world market – a position which she has only recently regained after the dislocations of war. The crop is grown in paddy fields which are separated from each other by mud banks. These are flooded, and the water level is always carefully controlled to keep pace with the growing crop. The harvest is in November and December. Burma's present total output of some 6½ million metric tons is less than that of pre-war days (average 7 million tons), and in 1961 she exported 1,591,000 metric tons compared with a pre-war average of 3 million tons.

The dry zone has a much wider range of crops than the delta region. Its low rainfall means that rice can only be grown with irrigation, and other crops such as millet, vegetables, cotton, tobacco, and sesamum are widely cultivated. In bad years rice has to be imported from the delta region to supplement local food supplies, and many farmers vary their diet with fish, which is the most important food after rice. In the thinly-populated mountain districts the inhabitants live by shifting cultivation.

In an attempt to raise the general standard of living and improve agricultural efficiency the government has undertaken a number of extensive development projects. Most important of these is the reclamation of some two million acres of land which has fallen idle since the war. There are also four major irrigation projects to serve the dry belt. The biggest of these will bring water to over four million acres. Emphasis is also being laid on raising the yield of crops by the increased use of fertilisers.

NATURAL VEGETATION

Differences in the natural vegetation of Burma correspond closely to variations in relief and climate. The Irrawaddy delta has swamp forests, while the coastal plains and ranges are densely covered with evergreen rain forest. Most of the dry belt has scrub or is semi-forest. Between these extremes is the monsoon forest, which covers much of the Pegu Yoma, the Shan Plateau, and the inner slopes of the Arakan Yoma. The trees of the monsoon forest are leafless during the hot weather, and it is here that the valuable teak, Burma's second most important export, grows.

MINERALS AND INDUSTRY

Burma has rich mineral deposits, but they have so far been little developed. Petroleum was a major export before the outbreak of the Second World War, but during the war many of the installations were destroyed and production fell. The main wells are at Yenangyuang and Chauk (south of Pakokku), and there are refineries at Syriam (near Rangoon) and at Chauk. Other minerals include coal (in the lower Chindwin valley), small deposits of iron ore, and a wide variety of metallic ores. The most important of these are silver, lead, zinc, tungsten, and tin. There are considerable tin deposits in Tenasserim which is an extension of the tin-bearing belt of Malaya. Precious stones, particularly rubies and sapphires, have long been obtained from the Shan Plateau, and jade from the north of the country is exported overland to China.

In the past Burma's industry was mainly confined to small rice-mills and saw-mills. But the government has undertaken a vast industrial development programme, centred mainly on Rangoon, the capital, and on Mandalay and Myingyan. An electrically-operated steel works, using scrap metal as its basic raw material, has been set up at Rangoon. Factories making cotton textiles, jute sacks, cement, chemicals, medicines, tiles and bricks, and consumer goods have also been established, and many of the existing rice-mills and saw-mills have been modernised and enlarged. The government has been able to undertake these schemes partly as a result of loans from China and West Germany.

COMMUNICATIONS

In spite of the increased use of modern methods of communication such as aeroplanes, the Irrawaddy still remains Burma's main transport artery. Many roads and railways were destroyed or badly damaged during the war, and this has been a severe handicap to development – for example, Burma has no rail links with her neighbours. But new equipment has been supplied to the railways, bridges have been repaired, and new roads are being built.

CITIES

The capital, and by far the most important city, of Burma is Rangoon. Situated at the mouth of one of the distributaries of the Irrawaddy, it controls both the Irrawaddy and Sittang routes to the interior. Under the British it also became the country's chief port, handling 85 per cent of her trade. Mandalay, in the dry zone, is the chief transportation and trading centre for the north. Burma's second port, Moulmein, is an important rice- and teak-exporting centre, while Tavoy, farther south, exports tin from the Tenasserim district. Mergui, the southernmost port, trades primarily with Malaya and is a pearl-fishing centre.

Statistics

Area	261,757 sq m
Population	21,526,824
Density of population	82 per sq m
Principal cities:	
Rangoon	740,000
Mandalay	186,000
Moulmein	103,000

Imports: machinery, cotton goods, iron & steel

Exports: rice, teak, metals, raw cotton

MINERALS

The brown 'scabs' on the skin of these apples are caused by a lack of the element boron in the soil

About 40 mineral elements

Of the hundred-odd elements known to chemists, about 40 are included by plants in their complicated diet. Some they use in large quantities, others in very minute amounts. The only way to obtain direct evidence about which elements plants use is to take samples of plant substance (leaves, wood, or roots) and find out what elements are present in them. This is done by *chemical analysis*; if a large quantity of an element is present this is fairly easy, but many elements are present only in minute traces, and these may be very difficult to find and identify.

IF you go to the greengrocer's shop to buy some apples you may well see some which are selling quite cheaply because they have brown patches on them; if you buy them you will find that they are rather sour. Probably the greengrocer will not be able to explain this, but, in fact, the most likely cause of the brown patches and the sour taste is a deficiency of boron in the soil in which they were grown.

Boron is an element unfamiliar to most of us, but it is present in minute quantities in most soils. If it is absent or insufficient, the growth of plants is affected. This was first discovered at Rothamsted Experimental Station in Hertfordshire when scientists were trying to find a substance which, added to the soil, would discourage aphids on beans. They were unsuccessful in this quest, but they did notice that when borax (a compound containing boron and sodium) was used the plants grew better.

It is now known that many elements are needed for the healthy growth of plants, some in fair quantities and others only in minute traces.

The plant is able to make its food from air, water, and minerals

THE FOOD OF PLANTS

Plants obtain their food from the air, from the water in the soil, and from mineral solutions dissolved in this water. Their power of photosynthesis (see page 332) enables them to make sugars by using energy from sunlight to combine water with carbon dioxide gas. These sugars then have to be combined with other elements to make the plant's living substance, protoplasm and the various tissues of which it consists.

It is these various elements, which are present in the water of the soil in the form of mineral solutions, that we are now going to talk about.

MINERALS ARE COMPOUNDS

In our article on leguminous plants (see page 2567) we saw that, although plants need nitrogen, they cannot normally make use of the pure nitrogen that is present in limitless quantities in the atmosphere. Only when the nitrogen is combined with other elements to make a compound, such as nitrate, can the roots of the plants absorb it.

It is just the same with the rest of the elements that plants need. If they were present in the soil as pure boron, pure phosphorus, or pure iron the plants could not take them up. They are only available to plants as chemical compounds of the elements. Nearly all minerals are compounds of this kind.

EACH MINERAL PLAYS ITS PART

The quantities of the different mineral elements taken up by plants vary considerably. There was quite a lot of potassium and magnesium in the clover (see above right), but only a very small amount of copper and zinc. This does not mean that the minerals required only in minute amounts are not

PHOSPHORUS is found in the nuclei of the cells and is necessary for cell-division and growth. Lack of it causes yellowing of the leaves, poor growth, and a defective root system.

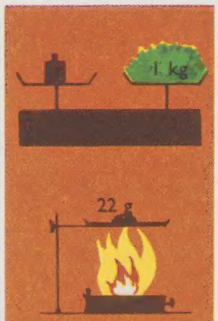
NITROGEN is necessary for the formation of chlorophyll and protoplasm. Shortage of it causes the whole plant to be stunted; the leaves first turn yellow, and then wither and die.

NEEDED BY PLANTS

A simple example of analysis

For our analysis we will take 1 kilogram of a common plant, clover. We dry it in an oven at a temperature of 105°C (metric measurements and Centigrade temperatures are always used in scientific work) and find that the dry residue weighs 163 grams. The other 837 grams were water, which has evaporated.

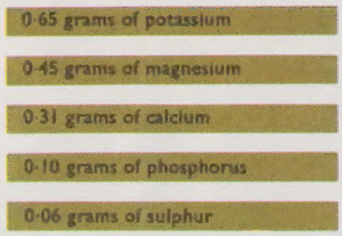
Now we put the dried clover in another oven at 550°C. This is hot enough to make it burn, and we are left with a small quantity of ash weighing 22 grams. The part that has now evaporated consisted of organic compounds of carbon, nitrogen, hydrogen, and oxygen. The 22 grams of ash represent the inorganic or mineral substances contained in 1 kilogram of clover.



The analysis of clover: 1 kg of the plant is reduced to 22 g of ash

Identifying the minerals

Complicated methods and expert knowledge are needed to find out what mineral elements, in what proportions, are contained in the clover ash.



Let us suppose that a qualified chemist has taken our 22 grams of ash and made a quantitative analysis of it. The amounts of potassium, magnesium, calcium, phosphorus, and sulphur that he finds are given above. Other elements, such as boron, copper, and zinc, will be present in much smaller quantities.

important; if any one of them is lacking the plant will suffer some defect.

The pictures below show the deficiency-effects of eight elements. The eight flower-pots were filled with sand which had been thoroughly washed with distilled water. A plant of the same kind and at the same stage of growth was put in each pot, and each one was watered with a solution containing all but one of the mineral elements which are essential to plant growth. Thus the first pot was given a solution in which all the elements except phosphorus were present in the form of suitable chemical compounds. The second had no nitrogen, and so on. The growth of the plants in the different pots was then carefully observed.

It is important in an experiment of this kind to keep everything very clean. If there is any dirt on any of the apparatus, it may contain traces of, say, manganese or iron, which would lead to a wrong result in the two plants which are being deprived of these minerals.

POTASSIUM is necessary for the process of sugar-making in the leaf (photosynthesis) and helps resistance to disease. Lack of it retards growth and causes the leaves to be discoloured.

CALCIUM neutralises excess acids formed when proteins are built up in the plant. Lack of it causes dying back at the growing points, wilting of the stems, and defective roots.

COPPER assists in the plant's respiration or use of oxygen. Lack of it causes deformed growth and dying back of growing points; leaves may show a bluish-green colour.

ZINC in very small quantities assists the growth of plants. Too much of it is poisonous to them, while lack of it causes poor growth and various kinds of deformity of the leaves.

MANGANESE is necessary for the formation of proteins and also assists respiration. Lack of it causes the leaves to lose their green colour, and the plants will not produce seed.

IRON is essential for the functioning of chlorophyll and so is vital to growth. Iron is always plentiful, but in some types of soil plants have great difficulty in absorbing it.

The first four pots each lack an element which is needed in considerable quantity; the fifth to eighth lack one, of which only a trace is needed

HISTORY OF RUSSIA (part three)

Lenin (1870–1924), the Bolshevik leader who took the Communists to power in Russia in 1917

MUCH of old Europe perished in the First World War, but nowhere with a more cataclysmic effect than in Russia. There the feeble, corrupt rule of the Romanov Tsars, Russia's leaders since the 17th century, ended in the holocaust of revolution. As the ill-equipped, badly-led Russian armies suffered disaster after disaster, the Russian people rose up against their hated government. The 'evil genius' of the regime, Rasputin, was assassinated in December 1916, and the following spring Tsar Nicholas, soon to meet his own violent death, was forced to abdicate. A liberal regime was set up under Alexander Kerensky. But this was only the beginning. On 8th November the revolutionary Bolshevik Party, dedicated under the leadership of Lenin to the Communist principles of Marx (see page 2960), seized power by force. This 'November Revolution' altered the course of history not only for Russia but for the world.

Russia under the Communists

Communist Russia, or the Union of Soviet Socialist Republics as she became, was the political outcast of Europe. She was fortunate that the Western allies returned some of the lands surrendered to the Germans by Lenin in the humiliating Peace of Brest-Litovsk in March 1918. But after the war Western statesmen, fearful and suspicious of a government which advocated class war and the extermination of the capitalists, left the Russians to solve their own problems, confident that the Communist regime could not survive.

The first problem facing the Communists was civil war. Large anti-Communist armies were raised, often with Western backing, and it was only in 1921 that these forces were defeated.

Years of terrible hardship followed as food supplies failed and famine destroyed millions. But the Communists, small in number yet fanatically dedicated, went ruthlessly on with their Marxist policies. Society was transformed. The State everywhere took the place of private enterprise. Property was confiscated, marriage turned into a State ceremony, and all available manpower conscripted for service to the State. The peasants' land was nationalised into collective farms; and although Lenin's New Economic Policy (1921–1928) reduced State control, his successor, Stalin, resumed collectivisation with frightful results. In 1928 his Five Year Plan included a drive to expand heavy industry which all but exhausted Russia's resources, and at the same time 26 million peasant holdings were turned into 235,000 collective farms. Peasants who did not co-operate were forcibly evicted and left to starve. It is thought that 5 million starved to death in 1933 alone.

Stalin was an unscrupulous man. He had climbed to power by ousting the outstanding Communist leader Leon Trotsky, and he maintained himself by bloody methods. His rivals within the Communist Party were eliminated, hundreds of party members dying in the frightful purges between 1936 and 1939.

The war and after

Stalin's vigorous planning had succeeded in building Russia into a far stronger nation than she had been under the Tsars. During the 1930s it became clear that a showdown was likely between the Communists and their most violent opponents, the German Nazis. By a piece of devious diplomacy Stalin arranged the partition of Poland with the Nazis in 1939 and stayed out of the Second World War until 1941. Then Hitler invaded Russia and soon Stalin was fighting alongside his capitalist allies, Great Britain and America.

After Germany's total defeat Russia emerged alongside the United States as one of the twin giants of world politics. Communist governments were set up in countries she had occupied in the course of the war, and Russia became ringed with 'satellite' countries controlled by her. After 1947 (see page 2822) an Iron Curtain divided Russia, with her satellites like Poland, Czechoslovakia, Hungary, East Germany, Bulgaria, and Romania, from the 'Free World'. Communist progress continued. China became Communist in 1949. In 1950 the Korean war was fought largely between American forces and Russian-supplied troops to decide whether Korea also should become Communist. It seemed as if at any moment a new world war would break out. The prospects of such a war were made even more frightful by the fact that after 1949 Russia, as well as America, had nuclear weapons.

Then, in 1953, Stalin died. His successors, first Malenkov and then Krushchev, were by no means 'soft' men, but it seemed as if both West and East realised the folly of pushing each other to the brink of war.

World tension eased, and although international crises continued to occur in many parts of the world, there is today a growing hope that 'peaceful co-existence' between the worlds of Communism and Democracy is possible. A rift between China and Russia has increased the possibilities.

In recent years Russia's progress has been no less startling than under Stalin. In 1958 Russia launched the first artificial satellite into space. Three years later she sent the first man into space. Subsequent achievements by Soviet space scientists have emphasised the fantastic progress Russia has made in the brief period since she was a backward, underdeveloped nation ruled by Tsars.

Territories gained by Russia after the Second World War, bringing her still farther into Europe

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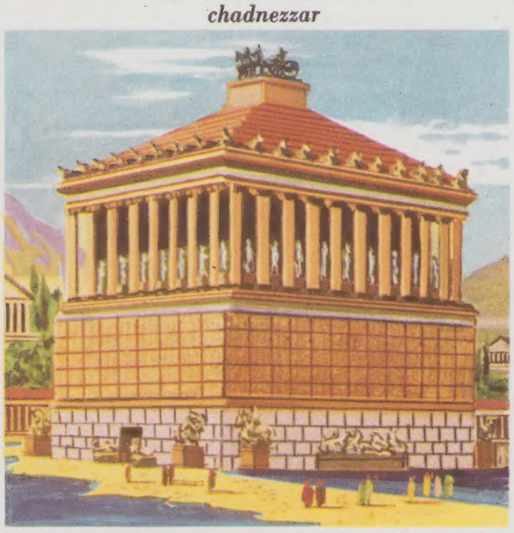
Herodotus said took 20 years, is perhaps the most extraordinary feat of building in history; for the Egyptians had no bulldozers, cranes, or pulleys – nothing but the simple lever, roller, and inclined plane. Thousands of slaves (Herodotus says 100,000) dragged the great blocks of stone from the quarries down to the Nile and ferried them across to the site. From a distance the Great Pyramid looks just as it always did except that it has lost its original polished-limestone casing and about 30 feet in height; the inside has long been gutted of all its valuables.

The Colossus of Rhodes

A colossus is a statue larger than life. The most famous colossus of antiquity is our second wonder – the Colossus of Rhodes, which was erected between 292 and 280 B C. The Colossus was a bronze statue of the sun god Apollo, cast by Chares of Lindos. No one knows exactly what it looked like; but the common view – that its legs straddled the entrance to the harbour, so that ships passed beneath it – is an invention of the Middle Ages. About 56 years after it was put up the Colossus was overthrown by an earthquake. Pliny, more than 300 years later, described its finger as larger than a statue of ordinary size; but this is an exaggeration, for the statue was, in fact, about 105 feet high. It disappeared in A D 672 when a Jew from Emesa bought the fragments, loaded them on to 900 camels, and carted them away.

The lush Hanging Gardens built by Nebuchadnezzar



The magnificent tomb of Mausolus, ruler of Caria

The Hanging Gardens of Babylon

The Greeks connected these with Semiramis, a legendary queen of Babylon, but they were, in fact, made for King Nebuchadnezzar (c. 605–562 B C). The gardens – trees, shrubs, and flowers of many varieties – were raised on a series of arched terraces near the river Euphrates. The problem of irrigating these spectacular gardens was solved, according to the Greek geographer Strabo, by raising water from the Euphrates by means of a screw.

The Mausoleum

Like the Great Pyramid, the Mausoleum was a tomb. Mausolus was a powerful ruler of Caria in Asia Minor who, by his lavish programme for beautifying his capital at Halicarnassus and his patronage of the arts, foreshadowed the Hellenistic kings of the next century. Mausolus died in 353 B C. His sister (who was also his wife) supervised the building of the tomb. This 'Mausoleum', designed by Pythius, was a rectangular building of the Ionic order; above the columns rose a pyramid roof topped by a four-horse chariot. An earthquake destroyed the Mausoleum before the 15th century; but in the last hundred years excavations have revealed fragments, including a statue of Mausolus himself which is almost intact.

The statue of Zeus at Olympia

The sculptor Pheidias (born c. 490 B C) was one of the greatest Greek artists. In the mid-5th century B C

Pheidias's masterpiece – the awe-inspiring statue of Zeus

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The Temple of Artemis at Ephesus

he was commissioned by Pericles to supervise the ornamentation of the Parthenon. He was also responsible for three of the most famous statues of antiquity: the colossal bronze figure of Athena on the Acropolis (sailors coming into Piraeus, the port of Athens, could see the sun twinkling on her spear from miles away); the gold and ivory statue of Athena inside the Parthenon; and that of Zeus which was made for the Temple of Zeus at Olympia.

Zeus, seated on a throne within his temple, was a towering figure over 40 feet high. In his right hand was a small statue of Victory, in his left a sceptre crowned with an eagle. His flesh was ivory, his robes gold; and his throne was inlaid with gold, ivory, ebony, and precious stones. A Roman writer, Quintilian, said that the beauty of Pheidias's Zeus had added something to traditional religion. We can only guess at its awe-inspiring effect, for there is no surviving picture of the statue. Some coins of the nearby city of Elis show a head of Zeus which may be copied from Pheidias's statue; and some moulds, on which the gold for the drapery was hammered into shape, were found by excavators near Pheidias's workshop at Olympia. But the statue itself was eventually taken to Constantinople where it was destroyed by fire.

The Temple of Artemis at Ephesus

'Great is Diana of the Ephesians' was the cry of the pagans of Ephesus in Asia Minor, when they realised that St Paul's preaching might destroy faith in their goddess Artemis (Diana was the Latin form of her name) and thus remove the livelihood of those who made and sold statuettes of the goddess to believers. The Artemis of Ephesus was a primitive Asiatic goddess, different in character from the Greek Artemis, goddess of the chase. The Temple of Artemis was the centre of this pagan cult. It was built after a madman had set fire to an earlier Temple of Artemis on the same site in 356 B C. Many of the women of Ephesus sold their jewellery to help pay for the new temple. The architect's name was Deinocrates, and one of those who is thought to have decorated it is the famous sculptor Scopas. Excavations have revealed that the Temple, which was one of the supreme examples of the Ionic order, measured slightly more than 418 feet by 239 feet. The columns were about 56 feet high, and were unusual in that they were adorned on their lower part with lifesize sculptured figures in relief.

The Lighthouse of Alexandria

The Pharos at Alexandria

The last of the seven wonders of the ancient world is the Lighthouse (Pharos) of Alexandria. When Alexander the Great conquered Egypt he founded a great new city on a neck of land between Lake Mareotis and the Mediterranean Sea. The city, like many other cities founded by Alexander, was named after him – Alexandria; and it soon became the greatest commercial and cultural centre of the Mediterranean world. Just offshore there is a small island called Pharos, which was linked to the mainland by a mole three-quarters of a mile long. Very likely the idea of building a lighthouse on Pharos island was Alexander's; but the plan was not carried out until the reign of Ptolemy Philadelphus. The new building must have been worth its great cost (800 talents), for the coastlands round Alexandria are flat and ships coming into port need guidance. The Lighthouse, which was given the same name as the island, was completed in 279 B C. It was about 400 feet high. The uppermost of its three stories had windows facing out to sea, and the light of the fire which burnt there all night could be seen from a great distance. Fuel for the fire was probably raised by a lift. References by ancient writers suggest that the light may even have been reflected and directed seawards by convex mirrors; possibly mirrors were used in the daytime to reflect the rays of the sun towards incoming ships; possibly the Alexandrians had even developed a lens which was used as a telescope, so that the Pharos was a watchtower as well as a lighthouse. Whatever the truth may be, the Pharos reflected the Alexandrians' interest in the applied sciences, and from a scientific point of view this creation of the designer Sostratus of Cnidos is perhaps the most remarkable of the seven wonders.

The Pharos was destroyed by stages. The lantern fell in about A D 700; the top story some 400 years later; and an earthquake in the 14th century reduced what remained to a mere stump. This earthquake, and that which ruined the Mausoleum, thus left the Pyramids – the oldest and most magnificent of the seven wonders – as the only survivor.